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# STUDIES

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## A DESCRIPTIVE ANALYSIS OF HOUSEFIRE DEATHS IN NORTH CAROLINA

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### ABSTRACT

Medical Examiner Investigation Reports dealing with housefire deaths in 1985 were linked to the Fire Marshal Investigation Reports. The study population totaled 200 deaths, representing 159 housefires. The overall housefire death rate in North Carolina was 3.2 per 100,000 population. Persons aged 65 and over had the highest age-specific death rate (8.4 per 100,000) and nonwhite males had the highest race-sex-specific death rate (7.1 per 100,000). Eighty-three percent of the decedents who died at the scene of the fire and were tested for carbon monoxide were determined to have died as a result of carbon monoxide poisoning. Thirty-three percent of the decedents died in fires started by heating units and 26% in fires started by smoking materials. Woodstoves and kerosene heaters caused the fires which accounted for more than half of the heating-related fire deaths. Of the decedents aged 15 and older, 56% had blood alcohol concentrations of .10% or greater. Decedents in cooking-related housefires had the highest percentage of intoxicated victims (85%) followed by decedents in smoking-related housefires (60%). The results of this study document the importance of providing automatic protection from injuries by modifying the environment to reduce housefire mortality in North Carolina.



## INTRODUCTION

One of the most important objectives of an epidemiological study on housefire mortality should be to describe the factors associated with the occurrence of the fire and the occurrence of the death. Such factors include the cause of the fire, the origin of the fire, the existence of a working smoke detector, and the blood alcohol concentration of the decedents. Once this information is known, prevention strategies could be developed on the state or local level.

An epidemiological study on housefire mortality would be very valuable to North Carolinians because, according to 1977-79 U.S. data, only seven states had higher housefire death rates than the state of North Carolina (1). Furthermore, many of the eastern counties in North Carolina are in the "Southeastern Atlantic Coastline Burn Belt," where many county housefire death rates are more than double the national rate. There has also been no indepth North Carolina housefire mortality study completed to date.

## BACKGROUND

In 1985, housefires were the fourth leading cause of all unintentional injury death (1.7 deaths per 100,000 population) in the United States, after motor vehicle deaths, falls, and drownings. However, among in-home deaths, housefires were second only to falls. The age groups with the highest death rates were persons 0-4 (3.8 per 100,000) and persons 65 and older (3.7 per 100,000). Males had a higher death rate per 100,000 than females (2.0 vs 1.3) and nonwhites had a higher death rate than whites (3.5 vs 1.3). The majority of housefire deaths in 1985 were attributed to carbon monoxide poisoning (73%) and burns (23%). (2,3)

In a national study based on an analysis of data obtained from the National Center for Health Statistics, State Fire Marshal reports, the National Fire Protection Association, and the Federal Emergency Management Agency's National Fire Incident Reporting System, the Federal Emergency Management Agency (FEMA) estimated that of the 6,200 residential fire deaths that occurred in 1978, 32% resulted from fires caused by smoking materials, 19% from fires caused by heating units, and 10% from fires considered "incendiary/suspicious." Among deaths in the Southeast, however, heating (35%), smoking

(27%), and cooking (10%) predominated. Many of the heating-related deaths in the Southeast resulted from stationary local heating units igniting flammable items such as bedding. (4)

Of the deaths in smoking-related fires, FEMA (4) reports that 87% involved cigarettes, nearly 89% occurred in the living room or the bedroom, and more than half involved the ignition of an upholstered chair or sofa. Mierley and Baker (5) reviewed 1976-1978 housefire deaths in Baltimore and found that 56% of the deaths were in cigarette-ignited fires. In a study examining fire deaths over a six-year period in Maryland, Birky (6) found that 45% of the fatalities were in smoking-related fires.

Of the deaths in heating-related fires, FEMA (4) showed that 34% were in fires caused by fixed local heating units, 19% in fires caused by central heating units, and 15% by portable heating units. Nearly 46% of the heating fire deaths were in fires caused by the misuse of the heating unit, such as when combustibles were placed too close to the unit or when a flammable liquid was misused. Thirty-eight percent of the heating fire deaths were in fires caused by equipment defects or malfunctions. Mierley and Baker (5) reported 20% of the deaths in their study were in fires caused by heating or electrical equipment while Birky (6) reported 15% due to these causes.

Housefire deaths by type of dwelling in the FEMA study (4) showed that one- and two-family dwellings accounted for 69% of the deaths, followed by apartments with 19% and mobile homes with 9%. The rate of deaths per 1,000 fires in the respective dwellings was 8 for one- and two-family dwellings, 10 for apartments and 22 for mobile homes. The increased risk of fire death in mobile homes was also reported in New Mexico, in which 27% of the fire deaths occurred in mobile homes even though mobile homes accounted for only 12% of year-round housing (7).

The role of alcohol in housefire deaths has been documented in several studies. Gerson (8) found that among adult housefire decedents over 18 in Ontario, 31% were impaired by alcohol. Birky (6) reported that 34% of all decedents in his study had blood alcohol concentrations greater than or equal to .10%. Finally, Mierley and Baker (5) found that 39% of housefire victims 15 years or older had blood alcohol concentrations of .10% or greater.



## METHODOLOGY

This descriptive epidemiological study examines all housefire deaths that occurred in North Carolina in 1985. Data on the decedents such as demographic and toxicologic information were obtained from the Office of the Chief Medical Examiner in Chapel Hill. Under North Carolina law, all suspicious, unusual, or unnatural deaths are investigated by licensed physicians participating in the Medical Examiner System. Housefire data, including cause and origin of the fire, were obtained from the Fire and Rescue Service Division of the N.C. Department of Insurance. For this study, a letter requesting information on specific housefires identified by the Medical Examiner System was sent out to the county or city fire marshals or county sheriffs who had a housefire death occur in their jurisdiction. In most cases, the fire marshal or sheriff returned his or her Housefire Investigation Report which detailed the circumstances surrounding the housefire. A "Housefire Abstract Form," combining housefire information with decedent information, was then completed (see Appendix I).

## RESULTS

### *Decedent Information*

A total of 200 housefire deaths were included in the study, representing 159 housefires. The crude death rate was 3.2 per 100,000 population\*. Housefire deaths in 1985 accounted for 75 percent of all North Carolina deaths due to fires and burns. Persons aged 65 and older had the highest age-specific death rate (8.4 per 100,000) followed by children aged 0-4 (5.5 per 100,000). Nonwhite males had the highest race-sex specific death rate (7.1 per 100,000) followed by nonwhite females (5.7 per 100,000). The rate of housefire deaths per 100,000 was slightly higher for males than for females (3.9 vs 2.5) but was much higher for nonwhites than for whites (6.4 vs 2.1).

Thirty-eight percent of the deaths occurred during December, January and February and 36% occurred on Saturday and Sunday. Forty-two percent of the deaths took place during the sleeping hours (11:00 PM - 4:59 AM). One hundred and eighty-three or 92% of the victims died at the scene of the fire.

\*Rates are approximate because some of the decedents may not have been North Carolina residents.

The Office of the Chief Medical Examiner's Toxicology Lab performed carbon monoxide tests on 157 (86%) of the victims who died at the scene of the fire, with 131 (83%) determined to have died as a result of carbon monoxide poisoning and 26 from burns. Of the 26 not tested for carbon monoxide, 7 (27%) were reported to have died from carbon monoxide while 19 were reported to have died from burns. Thus, persons who were tested for carbon monoxide were 3.1 times as likely to be reported as a carbon monoxide poisoning death compared with persons who were not tested.

### *Housefire Information*

Figure 1 depicts housefire deaths by cause of fire. Of the 183 cases for which cause of fire information was obtained, 33% were associated with heating and 26% with smoking. The majority of the "all other" category was undetermined cause of housefire. Of the 60 heating-related housefire deaths, 20% were in fires involving a flammable liquid and 25% were in fires involving the ignition of furniture or soft goods. Of the 47 smoking-related housefire deaths, 89% were in fires involving the ignition of furniture.

1985 North Carolina Housefire Deaths  
by Cause of Fire

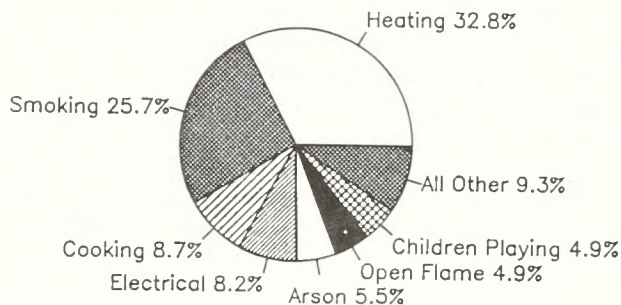
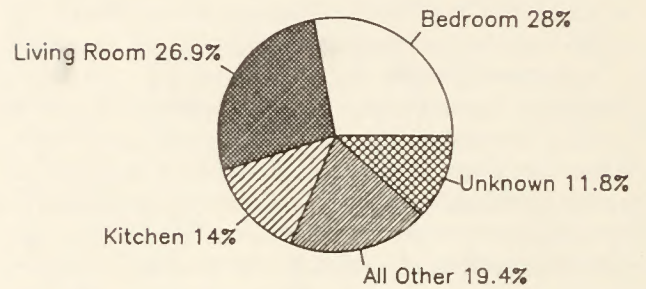


FIGURE 1

### 1985 North Carolina Housefire Deaths by Origin of Fire

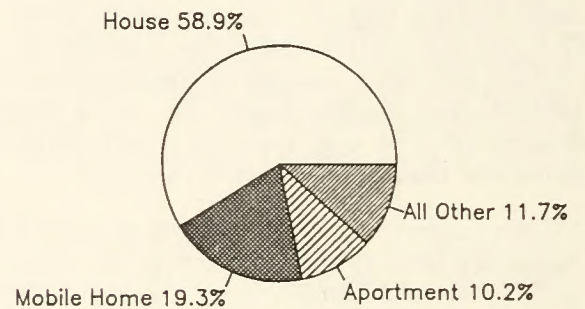
Figure 2 shows housefire deaths by origin of fire. Of the 186 cases with information about the origin of the fire, 28% were in housefires originating in the bedroom and 27% in the living room. Of the deaths due to fires originating in the living room, approximately half of those deaths were in heating-related housefires.



**FIGURE 2**

Figure 3 exhibits housefire deaths by type of dwelling. Of the 197 deaths for which type of dwelling information was available, 59% occurred in one-family houses and 19% occurred in mobile homes. Approximately one-half of the all other category was hotels, motels, and duplexes. Although population by dwelling type is not available for 1985, census data show that only 9% of the North Carolina population lived in mobile homes in 1980.

### 1985 North Carolina Housefire Deaths by Type of Dwelling



**FIGURE 3**



Figure 4 shows heating-related housefire deaths by the type of heating unit involved. Of the 60 heating-related housefire deaths, 37% were in housefires caused by woodstoves and 20% were in housefires caused by kerosene heaters. The majority of the "all other" category was unknown type of heating unit.

A map of county-specific housefire death rates over a six-year period (1980-85) is shown in Figure 5. Six years of housefire deaths from the Medical Examiner death files were used to stabilize the county rates. It can be seen that counties with the highest housefire death rates are in the eastern or "coastal plain" region of the state. For counties that had six-year housefire death rates of 6.0 or more (the state's six-year rate was 3.0), it was found that in 1985, 60% of these decedents were in heating-related fires. For counties that had six-year housefire death rates of 5.9 or less, however, only 28% of the housefire decedents were in heating-related fires.

Of the 80 cases for which information on age of dwelling was reported, the median age of the dwellings was approximately 38 years. Of the 109 cases for which information on smoke detectors was reported, 94% had no smoke detector present in the dwelling at the time of the fire.

1985 N.C. Heating-Related Housefire Deaths by Heating Unit Involved

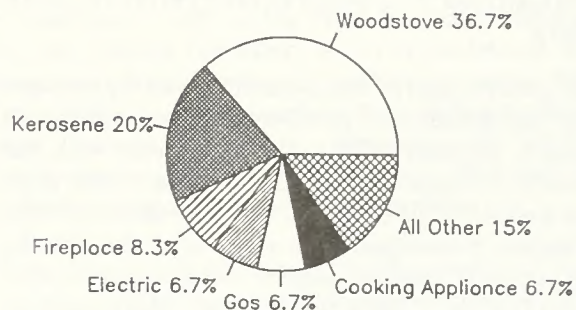


FIGURE 4

## Housefire Death Rates

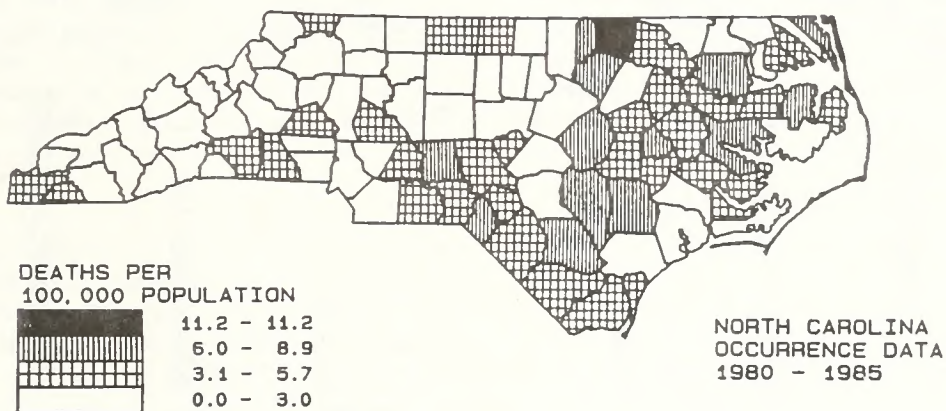


FIGURE 5

## Alcohol Involvement in Fires

Of the 160 housefire decedents aged 15 years and older, 130 (81%) were tested for blood alcohol. The reasons that some decedents were not tested include a long survival time after the injury and heavy charring of the body. Of those tested, 39% were negative, 5% had a blood alcohol level less than 100 mg% (less than 100 mg/dl or .10% blood alcohol concentration), and 56% had a level of 100 mg% or greater (A person is considered legally intoxicated in North Carolina if his blood alcohol percent is .10 or greater).

The percentages of intoxicated victims by race-sex group, age group, and cause of fire are exhibited in Figures 6 through 8. The race-sex groups with the highest percentage of intoxicated victims were non-white males (72%) followed by white males (65%). The highest percentage of intoxicated victims for the age groups were persons aged 45-64 (81%) followed by 25-44 (68%). Eighty-five percent of the decedents in cooking-related housefires were intoxicated compared to 60% of the decedents in smoking-related housefires. Undetermined and missing cause of housefire comprised the majority of the "all other" category in Figure 8.

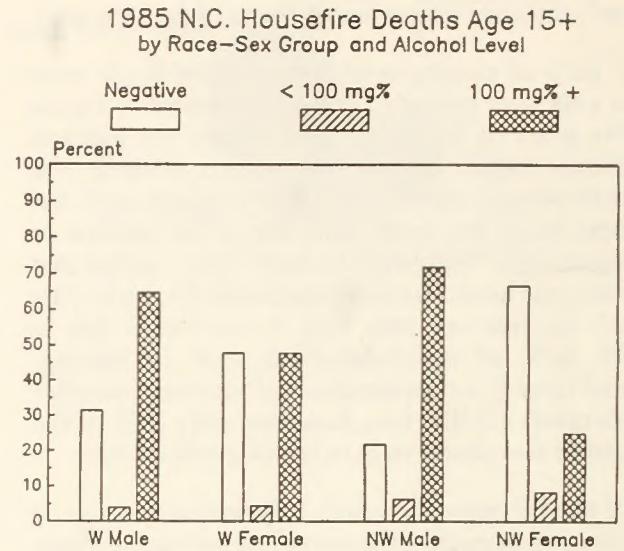


FIGURE 6

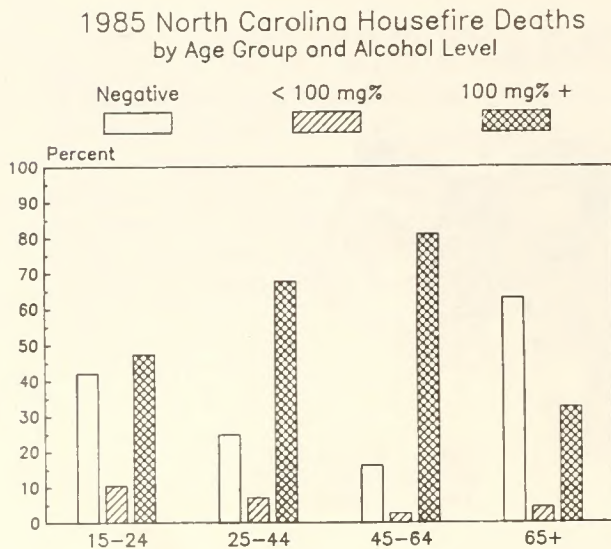


FIGURE 7

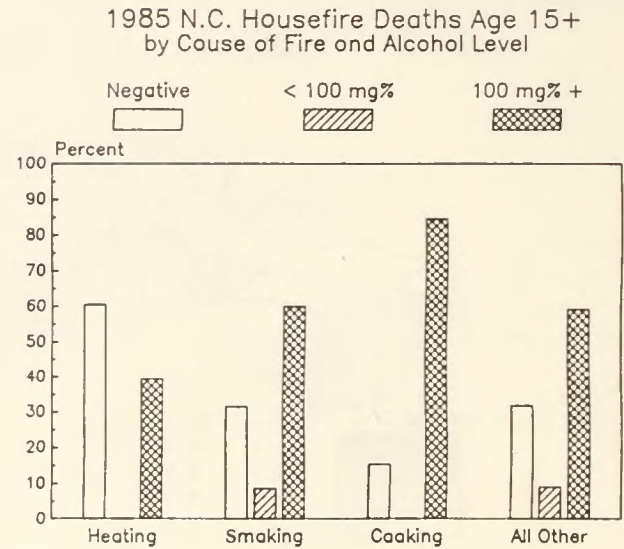


FIGURE 8



## DISCUSSION

The purpose of this descriptive study was to document and describe the factors associated with housefire mortality in North Carolina. It was found that heating units, smoking materials, alcohol intoxication, and carbon monoxide poisoning were all associated with housefire mortality. In contrast to national statistics, heating-related housefires in North Carolina accounted for more deaths than any other cause of housefire. Woodstoves and kerosene heaters caused the fires which accounted for more than 50% of these deaths.

Smoking-related housefires accounted for approximately one-fourth of the housefire deaths. Most of these fires involved furniture ignition while the decedent was intoxicated by alcohol.

Of the decedents aged 15 and older who were tested for blood alcohol, 56% had a level of .10% or greater. The corresponding percentages of intoxicated victims in other unintentional injury deaths in 1985 were 21% for falls, 32% for drownings, and 35% in motor vehicle crashes. The question arises, however, as to whether the alcohol intoxication contributed to the cause of the fire or simply prevented the decedent from getting out of the housefire, or both. More research is needed to address this issue.

Of the decedents who died at the scene of the fire and were tested for carbon monoxide, 83% were determined to have died from carbon monoxide poisoning. This percentage is 3.1 times the percentage for decedents who were not tested for carbon monoxide but were reported to have died from carbon monoxide poisoning. Although a selection bias may exist in which only the true carbon monoxide poisonings are tested, these results do highlight the importance of carbon monoxide testing to determine an accurate cause of death for a housefire fatality.

One major limitation of this descriptive study is the difficulty of determining relative risks associated with specific factors. For example, although the data show that housefires caused by woodstoves accounted for 22 deaths in 1985, we do not know how many people were exposed to woodstoves that serve as heating units. Therefore we cannot assess the relative contribution of woodstoves because the population at risk is not known.

Another limitation is the scarcity of data on the Fire Marshal reports. For example, there was very little documentation on the reason why the heating unit caused the housefire or whether the smoke detector in the home was working. Furthermore, 60% of the Fire Marshal reports had missing information on the age of the dwelling and 46% had missing information on smoke detector presence.

Even with these limitations, this study does suggest that, with an increased utilization of smoke detectors, many housefire deaths could be prevented. In 1985, approximately 2/5 of the fatal housefire injuries occurred during the hours when most people are asleep and approximately 2/3 of the decedents died from smoke inhalation/carbon monoxide poisoning rather than burns. Of the decedents for whom smoke detector information is known, 94% had no smoke detector present at the time of the fire.

The relationship between smoke detectors and housefire deaths has also been supported through data collected by the Federal Emergency Management Agency (FEMA) and the National Fire Protection Association (NFPA). The FEMA (4) study showed that when a fire occurred, the risk of dying in a home where detectors were not installed was twice the risk in homes where detectors were installed. The NFPA study (9) showed that only 14% of the 873 fire deaths which were investigated occurred in fires detected within five minutes of ignition while 63% of the fatalities occurred in fires detected 20 minutes or more after ignition (time of detection was estimated for each fire by the responding fire department). While limited by failing to take into account the behavioral characteristics of the people who have smoke detectors compared to the people who do not (FEMA study) and failing to include a control group consisting of people in nonfatal fires (NFPA Study), the results do suggest that early detection of housefires contributes to limiting housefire fatalities.

There is evidence documenting the need for more smoke detectors in North Carolina homes. The General Building Code in North Carolina requires that dwellings constructed after 1975 must have smoke detectors. There are many homes in the state, however, that were built before 1975 and the data collected in this housefire study showed that, of the housefire decedents for whom age of the dwelling was reported, 91% were in homes built before 1975. Furthermore, a 1982 telephone survey conducted by



The North Carolina Office of State Budget and Management showed that only 56% of North Carolina homes have smoke detectors (10).

One strategy to increase smoke detector prevalence is giveaway programs. The efficacy of such programs was studied by Gorman (11) after the Baltimore City Fire Department conducted a program aimed at the installation of a smoke detector in every city residence. He found that 92% of the inspected homes had a smoke detector installed and 88% of those smoke detectors were operational. Therefore, 81% of the inspected homes had an installed functional smoke detector. Although these results may not be applicable in North Carolina, smoke detector giveaway programs initiated by the fire departments and combined with instructions on proper installation, frequent testing, and the development of fire escape plans, may be beneficial in targeted communities.

Another strategy to increase smoke detector prevalence would be a state or county law which requires that smoke detectors be installed in *all* homes. The efficacy of such a law was studied by McLaughlin (12). She found that in a suburban county with a law requiring smoke detectors to be installed in homes already occupied, 82% of the homes had at least one working smoke detector compared to 70% in a neighboring control county. McLaughlin also suggests that, although a major argument against a retroactive smoke detector law was the difficulty of enforcement, the mechanism of requiring smoke detectors to be present when a house is sold appears to have been effective.

The prevention of heating-related fires might be facilitated by home inspection programs along with changing and/or enforcing the current building and housing codes to enhance fire safety. Although more research is needed on the specifics of how heating units cause housefires, the data collected in this study suggest that some heating-related housefires are preventable. The Consumer Products Safety Commission's recommendations on woodstoves suggest that proper clearance should be continuously maintained between nearby combustible materials and the woodstove and that flammable liquids should never be used to start or stoke a fire. The Commission also recommends that the woodstove be placed on a suitable floor protector to prevent the ignition of the floors and that the woodstove be placed at least 36 inches from side walls to prevent

the ignition of wall coverings. (13) For kerosene heaters, the Commission recommends that gasoline should never be used to start the heater and heaters should never be left unattended when operating (14). These and other recommendations by the Consumer Products Safety Commission should be incorporated into home inspection programs initiated by the community fire departments along with building and housing codes. Although studies (15,16) have shown the efficacy of home safety programs to be poor, changing and/or enforcing building and housing codes to enhance fire safety would give the fire department the leverage it needs to improve fire safety in the home.

A strategy to prevent smoking-related fires would be the required production of fire-safe cigarettes and cigars. McGuire (17) found that if smoking materials were manufactured to self-extinguish within 10 minutes of being placed on furniture, then ignition would most likely not occur. This strategy would probably be the most effective method to reduce smoking-related fires in North Carolina because most of these fires involved furniture ignition while the decedent was intoxicated by alcohol. Baker (1) suggests that the association between smoking and alcohol use is important because intoxication may increase the likelihood that a lighted smoking instrument will fall unnoticed onto furniture. After smoldering for several hours, this furniture may ignite and the fire can spread very rapidly. There have been attempts to decrease the flammability of the environment by adding chemicals to fabrics and by changing the construction of furniture. However, existing furniture, carpets and mattresses that are not fire resistant will probably be in use for the next 20-30 years. (17)

The production of fire-safe cigarettes and cigars could occur in the near future. The Cigarette Safety Act was signed in October 1984. This act established a 15-member Technical Study Group and charged this group to determine the technical and economic feasibility for cigarette manufacturers to produce fire-safe cigarettes. The Technical Study Group reported their findings to Congress in October of 1987. It found that the technical feasibility of producing fire-safe cigarettes has been confirmed by extensive studies conducted at the National Bureau of Standard's Center for Fire Research. Recommendations for making fire-safe cigarettes include the presence of a filter-tip, less porous paper, more



expanded tobacco, no citrate added to paper and, in some cases, a 21mm circumference cigarette rod. The Study Group also reported that the benefits of producing fire-safe cigarettes outweigh the costs to the industry. (18)

Unfortunately, some of the housefire deaths in the present study may not have been preventable because of the high alcohol intoxication levels of the decedents. For example, deaths from kitchen fires can probably be avoided by not leaving cooking food unattended, keeping curtains and other flammable items away from the cooking area, and by mounting a fire extinguisher near the kitchen (19). The high correlation between alcohol intoxication and cooking fire deaths, however, suggests that these recommendations might be ineffective. There is the question of whether an intoxicated person could take appropriate action even if a smoke detector signalled a fire. Overall measures to reduce alcohol abuse would likely have the result of reducing housefire deaths (20).

In conclusion, the results of this descriptive study document the importance of implementing passive means of intervention to reduce housefire mortality in North Carolina. Programs dealing with the installation and inspection of smoke detectors, the inspection of heating units, and the development of self-extinguishing cigarettes would probably be more effective and practical than programs designed to educate and change the behavior of persons at risk of housefire death. The results of the study also suggest that future research asking more specific questions on housefire mortality is needed. Fortunately, the North Carolina Fire Commission recently implemented a Fire Incident Reporting System in selected counties which will collect more specific and standardized information about the housefire. Furthermore, the University of North Carolina Injury Prevention Research Center received a grant from the Centers for Disease Control to study housefires. Some of the research questions deal with the efficacy of smoke detectors and the excess mortality associated with fires in mobile homes. It is hoped that the results of future research and greater implementation of passive intervention will reduce North Carolina's housefire mortality in the near future.





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## APPENDIX I

### Housefire Abstract Form

#### I. Decedent Information

A. Age in Years

B. Race

1. White
2. Black
3. Indian
4. Other
5. Unknown

C. Sex

1. Male
2. Female
3. Unknown

D. County of Injury

E. Zip Code of Injury

F. Date of Injury

G. Time of Injury : a.m. p.m.

H. Date of Death

I. Cause of Death

1. Carbon Monoxide
2. Burns
3. Other

J. Carbon Monoxide Concentration  %

K. Alcohol Concentration  %

#### II. Housefire Information

A. Cause of Fire

- |                          |                            |
|--------------------------|----------------------------|
| 1. Explosive             | 8. Electrical Distribution |
| 2. Incendiary/Suspicious | 9. Appliances              |
| 3. Children Playing      | 10. Other Equipment        |
| 4. Smoking               | 11. Open Flame             |
| 5. Natural               | 12. Other Flame            |
| 6. Heating               | 13. Other                  |
| 7. Cooking               | 14. Undetermined           |

B. Origin of Fire

- |                |                  |
|----------------|------------------|
| 1. Bedroom     | 7. Garage        |
| 2. Kitchen     | 8. Attic         |
| 3. Living Room | 9. Balcony/Porch |
| 4. Bathroom    | 10. Hallway      |
| 5. Cellar      | 11. Other        |
| 6. Chimney     | 12. Unknown      |

C. Form of Material Ignited

- |                         |                               |
|-------------------------|-------------------------------|
| 1. Structural Component | 4. Soft Goods, Curtains, etc. |
| 2. Furniture            | 5. Other                      |
| 3. Appliance            | 6. Unknown                    |

D. Flammable Liquid Involved

- |             |          |
|-------------|----------|
| 1. Gasoline | 3. Other |
| 2. Kerosene | 4. None  |

E. Heating Unit Involved in Fire

- |                       |                      |
|-----------------------|----------------------|
| 1. Woodstove          | 7. Coal/Wood Furnace |
| 2. Fireplace          | 8. Central Heater/AC |
| 3. Kerosene Heater    | 9. Other             |
| 4. Electric Heater    | 10. Unknown          |
| 5. Gas/Propane Heater | 11. None             |
| 6. Cooking Appliances |                      |

F. Type of Dwelling

- |                     |                |
|---------------------|----------------|
| 1. One-Family House | 6. Condominium |
| 2. Mobile Home      | 7. Hotel/Motel |
| 3. Apartment        | 8. Other       |
| 4. Townhome         | 9. Unknown     |
| 5. Duplex           |                |

G. Age of Dwelling in Years

H. Smoke Detector Present

1. Yes
2. No



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